

(19) World Intellectual Property Organization
International Bureau



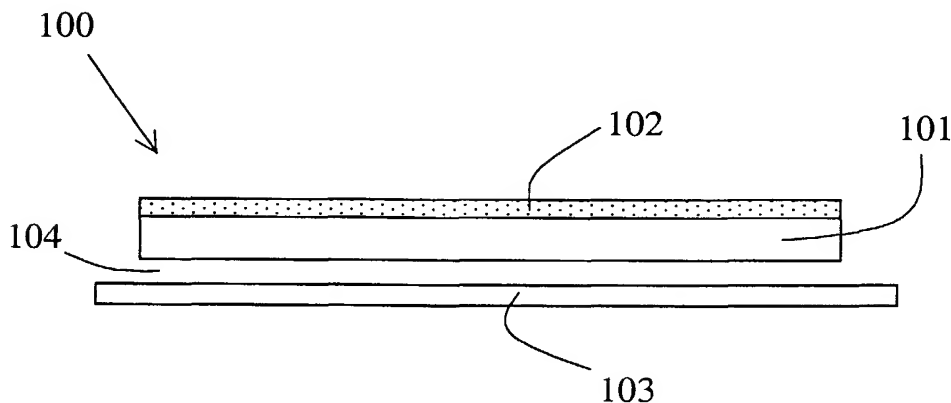
(43) International Publication Date
3 January 2003 (03.01.2003)

PCT

(10) International Publication Number
WO 03/001486 A1

- (51) International Patent Classification⁷: **G09F 9/35**, G02F 1/1335
- (74) Agent: **GÖTEBORGS PATENTBYRA DAHLS AB**; Sjöporten 4, S-417 64 Göteborg (SE).
- (21) International Application Number: PCT/SE01/01457
- (22) International Filing Date: 25 June 2001 (25.06.2001)
- (25) Filing Language: English
- (26) Publication Language: English
- (71) Applicant (for all designated States except US): **ARRAY DISPLAYS AB** [SE/SE]; Önnareds Brygga 13, S-421 57 Västra Frölunda (SE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **FRIES, Henrik** [SE/SE]; Drottninggatan 71-34, S-411 07 Göteborg (SE). **OUTGAJJOUFT, Jamilla** [SE/SE]; Kommendörsgatan 9 B, S-414 59 Göteborg (SE). **GRÖNDAHL, Jerker** [SE/SE]; Gibraltargatan 28, S-412 58 Göteborg (SE). **JAHNSSON-BOCK, Otto** [SE/SE]; Djurgårdsgatan 38 B, S-414 64 Göteborg (SE). **LUNDBERG, Håkan** [SE/SE]; Kondensatorsgratan 29, S-421 34 Västra Frölunda (SE).
- (81) Designated States (*national*): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELECTRICALLY CONTROLLED DISPLAY DEVICE



(57) Abstract: An electrically controlled device (100) comprising an active material capable of changing its optical appearance at least from a first display state to a second display state or vice versa depending on its energy level, and one or several control members arranged in contact with the active material for changing said energy level in at least portions of the active material in order to form a pattern visible to a viewer which can be dynamically controlled by means of the control member(s). The display device comprises at least one colored layer (102) arranged to cover at least a portion of the active material (101) towards the viewer, wherein the colored layer provides a first color and is semi-transparent and capable of transmitting more than 30% of incident white light in at least one of the display states in order to thereby change the viewer's color perception of the pattern.



WO 03/001486 A1

5 **Title**

Electrically controlled display device.

Technical field

10 The present invention relates to an electrically controlled display device which comprises an active material capable of changing its optical appearance at least from a first display state to a second display state or vice versa depending on its energy level, and one or several control members arranged in contact with the active material for changing the energy level in at least portions of the active material in order to form a
15 pattern visible to a viewer which can be dynamically controlled by means of the control member(s).

Background of the Invention

20 U.S. Patent No. 3,354,565 discloses an information display device comprising a substrate and an array of positive temperature coefficient (PTC) heating elements upon one surface of the substrate, wherein the array is so arranged that select ones of the PTC-elements define a form of information representation. The display device further comprises a layer of thermochromic material overlying the array, and means
25 for energizing the select ones of the PTC heating elements in order to cause portions of the thermochromic layer overlying the select ones to change color and display the form of information representation.

US 3,354,565 further discloses a passive display device comprising a substrate and an
30 array of resistors upon one surface of the substrate. The array is so arranged that select ones of the resistors define a form of information representation, wherein the resistors are formed of a material which exhibits a positive temperature coefficient of resistance. The display device further comprises a layer of thermochromic material overlying the array, and means for producing current in the select ones of the resistors

in order to heat them and cause portions of the thermochromic layer overlying the select ones to heat to the transition temperature of the thermochromic layer and change color thus displaying the form of information representation. Thereby, the resistors limit the temperature rise in the thermochromic layer to a point slightly over
5 the transition temperature. According to US 3,354,565, a number of thermochromic materials with various characteristics are available, e.g. certain iodides and bromides, oxides, sulfides, chromates, borates, coordination complex compounds, as well as numerous organic compounds. In addition to being reversibly thermochromic, the thermochromic material should have physical and chemical stability, low specific
10 heat, and be easy and convenient to apply to the underlying substrate.

The technology displayed in US 3,354,565 is claimed to provide a means for limiting the temperature variation in all types of information displays which utilize a temperature or thermal drive in their operation, and primarily for limiting the
15 temperature rise in thermochromic layer above the transition temperature point.

U.S. Patent No. 4,992,242 discloses an electronically controlled display apparatus suitable for generating heat in a selected pattern in order to display information. The apparatus comprises a resistive element at least part of which exhibits a PTC behavior
20 with a switching temperature and a first electrode attached to a first surface of a resistive element. A first electrical lead is connected to the first electrode and can be connected to a power supply. Furthermore, a plurality of second electrical leads each of which is connected to one of the second electrodes and can be connected to a power supply so that, when the first electrical lead and at least one selected second
25 electrical lead are connected to a suitable power supply, current flows through the resistive element and thus selectively generates heat therein in a pattern which is determined by the selection of the second electrical leads and is used to display information.

30 According to US 4,992,242, the information can be displayed by means of a thermochromic material, which undergoes a reversible and visually observable change in response to the selective generation of heat in the resistive element. The thermochromic material may be inorganic, e.g. mercuric oxide, mercuric iodide or

cuprous iodide, or organic, e.g. a polymer or liquid crystal. Thermochromic materials comprising a transparent matrix material such as silicone and an indicating material such as a particulate wax or other polymer dispersed within the matrix material are preferred. The thermochromic material may be applied directly to the resistive
5 element, or applied to a substrate such as a transparent polymer layer of silicone of polycarbonate which then can be laminated or adhesively attached to the resistive element. The apparatus further may comprise an insulating layer for electrical insulation and environmental protection, particularly when the display is used outdoors. Furthermore, the insulating layer minimizes possible diffusion of wax
10 components included in the thermochromic material.

According to US 4,992,242, additional layers of adhesive or pigment may be used as part of the apparatus in order to modify the background appearance, or the color of the display. Pigmented masks may be used in order to provide a sharper image, to use less
15 power in the display, to use less thermochromic material, or to enhance the adhesion between adjacent layers. Furthermore, the apparatus may comprise timing mechanisms such as clocks or bimetallic switches used to turn the display on or off at appropriate times. This is claimed to be particularly useful for signs which display a single message at specified timed or under specified conditions but remain blank or
20 opaque at other times.

In some embodiments disclosed in US 4,992,242, a backplane inscribed with a plurality of electrical traces is provided. Thereby, panels comprising a resistive element with first and second electrodes and a thermochromic material can be
25 deposited onto the backplane. This is claimed to allow easy modification of the display by changing the panels but leaving the backplane which can be connected to a source of electrical power. In its most simple version, such a display could be used for a dot matrix pattern.

30 The apparatus disclosed in US 4,992,242 is claimed to provide advantages such as a uniform and reproducible display. Furthermore, it is reported that the apparatus can be made in large sizes, with a simplified electroding and complex patterns.

The international patent application No. PCT/SE94/00430 discloses a display for digital/analogous visualization of computer stored and bitmapped information in the form of still or moving patterns, e.g. text, image or the like on, or by means of, at least one visualization medium. The disclosed display device consists of a matrix including at least two sets of electrodes crossing each other, spaced from each other by means of at least one resistive and/or inductive spacer means, and connected to at least one control device for multiplexing, scanning, or pulsating the control signals. Thereby, the electrodes are individually addressable in accordance with electric signals from a control unit and so provided that when selected, the electrodes in both sets of the electrodes are energized and a temperature change is obtained in the crossing point of the electrodes. The temperature change (heat) is conducted against said medium, which includes a thermosensitive indicating means, such as a layer, body, or the like, and a surface or surfaces in the display is/are provided to transform the temperature change to visible dots or the like.

The technology disclosed in PCT/SE94/00430 provides a display for still and moving images, for example consisting of characters and/or patterns, which display can be manufactured simply and with low cost, having few parts, and can be made flexible for certain applications. The display can be utilized e.g. for shelf-marking in order to display article and price information.

The international patent application No. PCT/SE97/01925 discloses an information display device which comprises a matrix comprising a first set of electrodes and a second set of electrodes, wherein the first and second sets are connected to control means for multiplexing, scanning, or pulsing electric signals to the electrodes. The device further comprises a plurality of heating means electrically connected between the first and second electrode sets at each cross point between electrodes from each of the first and the second electrode sets, and a thermosensitive layer capable of changing state from opaque to transparent depending on its temperature, wherein the thermosensitive layer is arranged in thermal contact with the heating means. The matrix further comprises a plurality of diodes, with a diode arranged at each of the

cross points so that a current can only flow from one current carrying electrode of the first set via the heating means to the corresponding electrode in the second set.

PCT/SE97/01925 further discloses an information display device which comprises a matrix comprising a first set of electrodes and a second set of electrodes, wherein the first and second sets are connected to control means for multiplexing, scanning or pulsing electric signals to the electrodes. This display device further comprises a plurality of heating means electrically connected between the first and second electrode sets at each cross point between electrodes for each of the first and second electrode sets, and a thermosensitive layer capable of changing state from opaque to transparent depending upon its temperature, wherein the thermosensitive layer is arranged in thermal contact with the heating means. Thereby, the matrix comprises a plurality of driving means, wherein a driving means is arranged at each of the cross points and is energizing only its corresponding heating means.

15

The technology disclosed in PCT/SE97/01925 provides an information display device for visualizing computer generated image information whilst minimizing the energy used for this process, and for visualizing computer generated image information using gradual color or grey-scales.

20

Furthermore, the international patent application No. PCT/SE99/00314 discloses an electrically controlled display device for generating heat in a selected pattern in order to display information. The device comprises a thermosensitive material applied in a thin layer which changes its optical appearance from a first state to at least a second state or vice versa depending upon its temperature, and an array of resistors arranged on a thin flexible film in columns and rows with each column comprising one resistor from each row and each row comprising one resistor from each column. Each one of the resistors has a thin planar configuration, extends in the plane of the flexible film and essentially covers a substantially square-shaped area defined by overlapping parts of a row and a column, wherein the resistors are arranged to emit heat energy all over the substantially square-shaped area when fed with electrical current. The thin layer with thermosensitive material is applied directly in thermal contact with the thin

25
30

flexible film and covers the rows and columns, wherein the display device further comprises means for controlling the temperature in each of the areas by measuring current variation through at least each resistor and controlling the electrical current and/or resistor shape or dimension.

5

However, the previously known display devices can be perceived as having certain disadvantages. One such disadvantage is that they usually are limited to displaying or not displaying an image or a message in one or several predetermined colors. Accordingly, a display device in accordance with the prior art might be limited to display a predetermined message of a first color against a background color, or to not display the message but only the background color.

Since display devices of the type in question often are intended for commercial messages and other messages which should be as eye-catching as possible, there is still a need for display devices comprising a thermosensitive material or another active material which can provide a greater freedom of choice when the color or hue of the displayed image or message, the foreground and background color, and the number of different images or messages which can be displayed are concerned.

Furthermore, there is a need for display devices which are able to display a message with an improved contrast to the viewer.

Summary of the invention

Accordingly, a first object of the present invention is to provide an electrically controlled display device which provides an improved flexibility when the color or hue of the displayed image or message, the foreground, and the background are concerned, and which display device is able to display an image or a message with an improved contrast to the viewer.

30

In accordance with claim 1, this first object is achieved by means of an electrically controlled display device comprising an active material capable of changing its

optical appearance at least from a first display state to a second display state or vice versa depending on its energy level, and one or several control members arranged in contact with the active material for changing the energy level in at least portions of the active material in order to form a pattern visible to a viewer which can be
5 dynamically controlled by means of the control member or members.

According to the invention, the display device comprises at least one colored layer arranged to cover at least a portion of the active material towards the viewer, wherein the colored layer provides a first color and is semi-transparent and capable of
10 transmitting more than 30% of incident white light in at least one of said display states in order to thereby change said viewer's color perception of said pattern.

The above-defined technical features enables the display device according to the invention to display exactly the color or hue which is desired for the image or
15 message in question, and with an improved contrast.

Brief description of the drawings

Fig. 1 shows a schematic sectional view of an electrically controlled display device
20 100 according to a first preferred embodiment of the invention,

Fig. 2 shows a schematic sectional view of a display device 200 according to a second embodiment of the invention,

25 Fig. 3 shows a schematic sectional view of a display device 300 according to a third embodiment of the invention,

Fig. 4 shows a schematic sectional view of a display device 400 according to a fourth embodiment of the invention,
30

Fig. 5 shows a schematic sectional view of a display device 500 according to a fifth embodiment of the invention, and

Fig. 6 shows a schematic sectional view of a display device 600 according to a sixth embodiment of the invention.

Detailed description of embodiments

5

In the following, a preferred embodiment and a number of alternative embodiments of the invention will be described in greater detail with reference to the attached Figs. 1 – 6.

10 The electrically controlled display device 100; 200; 300; 400; 500; 600 according to the invention comprises an active material capable of changing its optical appearance at least from a first display state to a second display state or vice versa depending on its energy level, and one or several control members arranged in contact with the active material for changing the energy level in at least portions of the active material
15 in order to form a pattern visible to a viewer which can be dynamically controlled by means of the control member(s). Suitable active materials and control members are previously known *per se*, e.g. from the above-mentioned prior art patent publications, and will not be describe in any greater detail herein.

20 However, the active material preferably comprises polymer liquid crystals (PLC) or polymer-dispersed liquid crystals (PDLC), and alternatively comprises a leuco-dye.

The control members preferably comprise one or several heat transfer devices (not shown in the drawings) in thermal contact with the active material for changing the
25 temperature in at least portions of the active material, but also other suitable means for changing the energy level of the active material can be utilized. Advantageously, the heat transfer devices can comprise resistors of a type disclosed in the above-mentioned PCT/SE99/00314.

30 The heat transfer devices, or control members of another type, advantageously can be attached to, printed onto, or integrated into one or several substrates included in the display device according to the invention, and/or electrical conduits for supplying or interrupting an electrical current to at least one of the control members can be

attached to, printed onto, or integrated into the substrate or substrates, which advantageously is/are flexible printed circuit.

In a preferred embodiment of the invention, the display device comprises at least one colored layer 102; 202; 302; 402; 502, 502'; 602, 602', 602'', 602''' arranged to cover at least a portion of the active material 101; 201; 301; 401, 501; 601, 601', 601'' towards the viewer, wherein the colored layer provides a first color and is semi-transparent and capable of transmitting more than 30% of incident white light in at least one of the display states in order to thereby change the viewer's color perception of the pattern. Thereby, the colored layer enables the display device according to the invention to display exactly the color or hue which is desired for the image or message in question, and with an excellent contrast, since the colored layer lets through a sufficient proportion of the incident light in order to allow the active material and its different display states to be clearly visible to the viewer.

In a second embodiment of the invention, illustrated in Fig. 2, the display device comprises a front substrate 202 intended to be facing towards the viewer and a back substrate 203 intended to be facing away from the viewer, wherein the active material 201 is located between the front substrate and the back substrate. In the second embodiment, the front substrate 202 constitutes the colored layer providing the first color in at least one of the display states, wherein the back substrate 203 provides a second color, enabling the viewer to perceive the pattern as being of the first color when the active material is in the first display state, and as being of a third color, different from the first and second colors, when the active material is in the second display state.

In the preferred embodiment, as illustrated in Fig. 1, the front substrate 102 supports the active material 101 on one of its surfaces, and the back substrate 103 is arranged at a distance 104 from the active material 101.

In another embodiment (not shown), the back substrate supports the active material on one of its surfaces and is arranged at a distance from the front substrate.

In still another embodiment, illustrated in Fig. 2, the back substrate 203 is attached to the front substrate 202 at least partially via the active material 201.

- 5 The colored layer 102; 202 preferably is a transparent polymer film comprising a pigment and/or a dyestuff providing a first color making the colored layer semi-transparent in both the first and the second display states.

10 In an alternative embodiment, the colored layer 302 comprises a pigment 305 and/or a dyestuff providing a first color, and further comprises at least a portion of the active material 301 making the colored layer 302 semi-transparent in at least one of the display states.

15 In another embodiment the colored layer is a varnish 502 comprising a pigment and/or a dyestuff providing a first color and making the colored layer semi-transparent in both the first and the second display states.

20 In a particularly advantageous embodiment, the display device 400; 500; 600 comprises at least two of the colored layers 402, 402'; 502, 502'; 602, 602' with at least a portion of the active material 401; 501; 601 in between. In this embodiment, advantageously at least two colored layers 402, 402' both provide the first color, thereby enabling the viewer to perceive different hues of the first color depending on the display state of the active material 401. Even more advantageously, at least two colored layers comprises a first layer 502 providing the first color and a second layer 25 502' providing a third color different from the first color, thereby enabling the viewer to perceive different colors depending on the display state of the active material 501.

30 In another advantageous embodiment, illustrated in Fig. 6, the at least two colored layers comprise portions of the active material 601, 601', 601'' alternating with the colored layers 602, 602', 602'', 602''', wherein the number of the colored layers is more than three and the number of the colors provided by the colored layers is more than two. This embodiment enables a larger number of colors or hues to be displayed than previously possible.

In another particularly advantageous embodiment, illustrated in Fig. 5, the at least one colored layer 502 arranged to cover at least a portion of the active material 501 towards the viewer absorbs substantially all incident light of a color which otherwise would be reflected back through the active material 501 from a further colored layer 502' and/or back substrate 503 behind the active material 501. This embodiment enables an enhanced contrast.

In an alternative embodiment, also illustrated in Fig. 5, a back substrate 503 is arranged behind the at least one colored layer 502 with the active material 501 therebetween, wherein a surface of the back substrate 505 facing the active material 501 exhibits cavities, apertures, protrusions, fiber ends 505, or other surface elements intended to maximize the absorption of incident light passing through the active material.

In a further alternative embodiment, illustrated in Fig. 5, the at least one colored layer 502 has a surface facing away from the active material 501 which exhibits surface irregularities 506 intended to enhance diffuse scattering of incident light.

In still another alternative embodiment (not shown), at least one colored layer has internal irregularities, particles or cavities filled with a gas, intended to enhance diffuse scattering of incident light or comprises a fluorescent pigment or dyestuff.

Advantageously, the active material 501 is white below a transition temperature and transparent above the transition temperature, but also active materials exhibiting other or a larger number of display states than two can be utilized.

In another alternative embodiment, a back substrate 503 which is substantially black is arranged behind the at least one colored layer 502 with the active material 501 therebetween, wherein the colored layer comprises a milk-white filter.

The layer(s) or substrate(s) included in the display device according to the invention advantageously comprise(s) a polymer film, e.g. of PET. The polymer film or films advantageously can be designed to control the influence of external degrading forces, e.g. humidity, uv-light, and oxygen on the active material. This “protective film” effect can be achieved either by means of integrating the active material into one or several polymer films, or by means of arranging the active material adjacently to a polymer film or between several polymer films.

The active material advantageously, but not necessarily, can be arranged in the form of a matrix or pattern of active dots, e.g. as dots (pixels) in a matrix covering the entire display area. By means of such a X-Y matrix, the entire display area can be dynamically controlled. Alternatively, the active material can be applied as active areas and/or indicia formed by the active material to provide an on/off function in a predetermined portion of the display area.

The active material can be applied by means of printing onto one or several of the layers or substrates included in the display device according to the invention. Suitable printing techniques should be wellknown to the skilled person. However, within the scope of the present invention, it is also conceivable with embodiments where the active, preferably thermosensitive material has been applied or mounted by means of another suitable technique, e.g. by means of providing thermosensitive material on a suitable carrier, e.g. in the form of particles, or in the form of an extruded film.

Preferably, the active material has a layer thickness larger than 6 μm in all areas which are to be dynamically controlled. This ensures that the viewer perceives a sufficient contrast between the different energy levels of the active material.

The present invention is not limited to the embodiments described above, but may be varied within the scope of the appended patent claims.

Accordingly, if necessary, the display device can comprise a suitable heating or cooling device for controlling the general temperature level of the display device.

This is particularly useful when the display device is intended for use outdoors or in a very cold or hot position.

5 Claims

1. An electrically controlled display device,
said device (100; 200; 300; 400; 500; 600) comprising:

an active material capable of changing its optical appearance at least from a
10 first display state to a second display state or vice versa depending on its energy level,
and

one or several control members arranged in contact with said active material
for changing said energy level in at least portions of said active material in order to
form a pattern visible to a viewer which can be dynamically controlled by means of
15 said control member(s),

c h a r a c t e r i z e d i n that the display device comprises at least one colored layer
(102; 202; 302; 402; 502; 602) arranged to cover at least a portion of said active
material (101; 201; 301; 401, 501; 601, 601', 601'') towards said viewer, wherein
said colored layer provides a first color and is semi-transparent and capable of
20 transmitting more than 30% of incident white light in at least one of said display
states in order to thereby change said viewer's color perception of said pattern.

2. An electrically controlled display device according to claim 1,
wherein said display device comprises a front substrate (202) intended to be facing
25 towards said viewer and a back substrate (203) intended to be facing away from said
viewer, wherein said active material (201) is located between said front substrate and
said back substrate,

c h a r a c t e r i z e d i n that said front substrate (202) constitutes said colored layer
providing said first color in at least one of said display states, wherein said back
30 substrate (203) provides a second color, enabling said viewer to perceive said pattern
as being of said first color when said active material is in said first display state, and
as being of a third color, different from said first and second colors, when said active
material is in said second display state.

3. An electrically controlled display device according to claim 2,
c h a r a c t e r i z e d i n that said front substrate (102) supports said active material
(101) on one of its surfaces, and said back substrate (103) is arranged at a distance
5 (104) from said active material (101).
4. An electrically controlled display device according to claim 2,
c h a r a c t e r i z e d i n that said back substrate supports said active material on one
of its surfaces and is arranged at a distance from said front substrate.
- 10 5. An electrically controlled display device according to claim 2,
c h a r a c t e r i z e d i n that said back substrate (203) is attached to said front
substrate (202) at least partially via said active material (201).
- 15 6. An electrically controlled display device according to any one of claims 1 - 5,
c h a r a c t e r i z e d i n that the colored layer (102; 202) is a transparent polymer
film comprising a pigment and/or a dyestuff providing a first color making said
colored layer semi-transparent in both said first and said second display states.
- 20 7. An electrically controlled display device according to any one of claims 1 - 5,
c h a r a c t e r i z e d i n that the colored layer (302) comprises a pigment (305)
and/or a dyestuff providing a first color, and further comprises at least a portion of
said active material (301) making said colored layer (302) semi-transparent in at least
one of said display states.
- 25 8. An electrically controlled display device according to any one of claims 1 - 5,
c h a r a c t e r i z e d i n that the colored layer is a varnish comprising a pigment
and/or a dyestuff providing a first color and making said colored layer semi-
transparent in both said first and said second display state.
- 30 9. An electrically controlled display device according to any one of the preceding
claims, c h a r a c t e r i z e d i n that said display device (400; 500; 600) comprises at

least two of said colored layers (402, 402'; 502, 502'; 602, 602') with at least a portion of said active material (401; 501; 601) in between.

10. An electrically controlled display device according to claim 9,
5 characterized in that said at least two colored layers (402, 402') both provide said first color, thereby enabling said viewer to perceive different hues of said first color depending on said display state of said active material (401).

11. An electrically controlled display device according to claim 9,
10 characterized in that said at least two colored layers comprises a first layer (502) providing said first color and a second layer (502') providing a third color different from said first color, thereby enabling said viewer to perceive different colors depending on said display state of said active material (501).

12. An electrically controlled display device according to any one of the preceding
15 claims, characterized in that said at least two colored layers comprise portions of said active material (601, 601', 601'') alternating with said colored layers (602, 602', 602'', 602'''), wherein the number of said colored layers is more than three and the number of said colors provided by said colored layers is more than two.

20
13. An electrically controlled display device according to any one of the preceding claims, characterized in that said at least one colored layer (502) arranged to cover at least a portion of said active material (501) towards said viewer absorbs substantially all incident light of a color which otherwise would be reflected back
25 through said active material (501) from a further colored layer (502') and/or back substrate (503) behind said active material (501).

14. An electrically controlled display device according to any one of the preceding
30 claims, characterized in that a back substrate (503) is arranged behind said at least one colored layer (502) with said active material (501) therebetween, wherein a surface of said back substrate (505) facing said active material (501) exhibits cavities,

apertures, protrusions, fiber ends (505), or other surface elements intended to maximize the absorption of incident light passing through said active material.

15. An electrically controlled display device according to any one of the preceding
5 claims, characterized in that said at least one colored layer (502) has a surface facing away from said active material (501) which exhibits surface irregularities (506) intended to enhance diffuse scattering of incident light.

16. An electrically controlled display device according to any one of the preceding
10 claims, characterized in that said at least one colored layer has internal irregularities, particles or cavities filled with a gas, intended to enhance diffuse scattering of incident light.

17. An electrically controlled display device according to any one of the preceding
15 claims, characterized in that said at least one colored layer comprises a fluorescent pigment or dyestuff.

18. An electrically controlled display device according to any one of the preceding
20 claims, characterized in that the active material comprises polymer liquid crystals (PLC) or polymer-dispersed liquid crystals (PDLC).

19. An electrically controlled display device according to any one of claims 1 - 17,
characterized in that the active material comprises a leuco-dye.

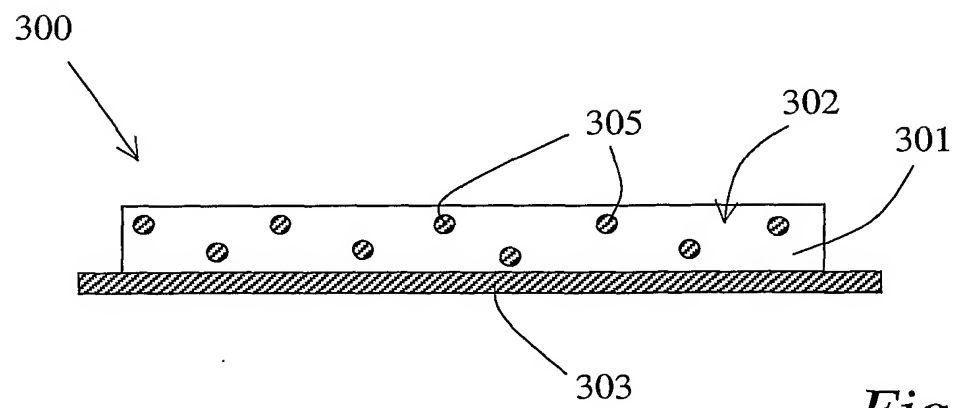
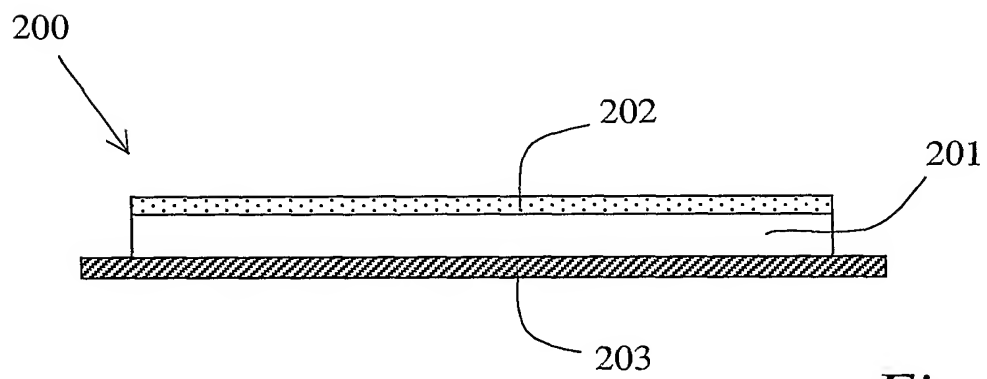
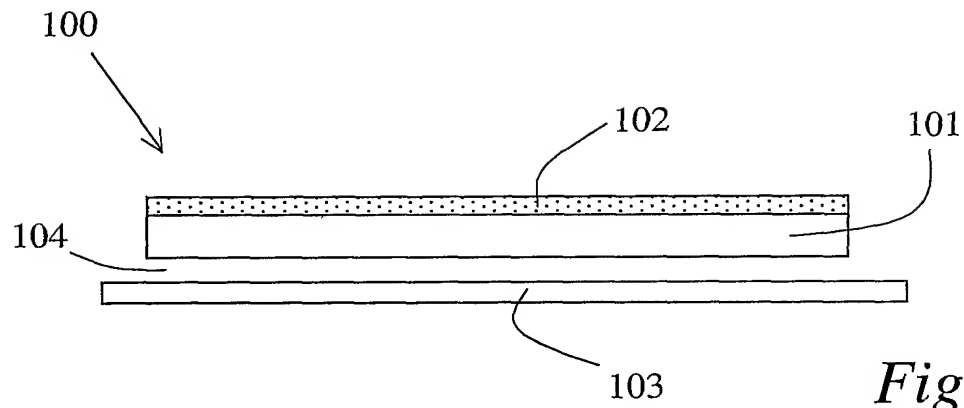
20. An electrically controlled display device according to any one of the preceding
25 claims, characterized in that the active material (501) is white below a transition temperature and transparent above said transition temperature,

21. An electrically controlled display device according to any one of claims 1-20,
30 characterized in that a back substrate (503) which is substantially black is arranged behind said at least one colored layer (502) with said active material (501) therebetween, wherein said colored layer comprises a milk-white filter.

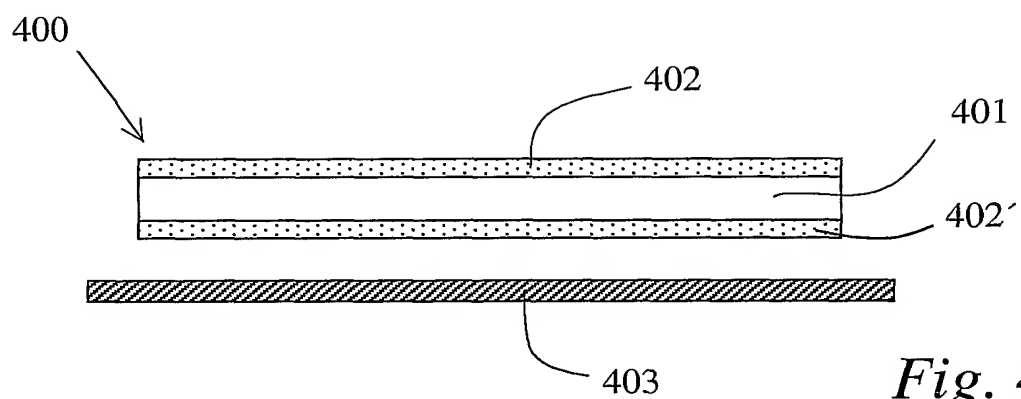
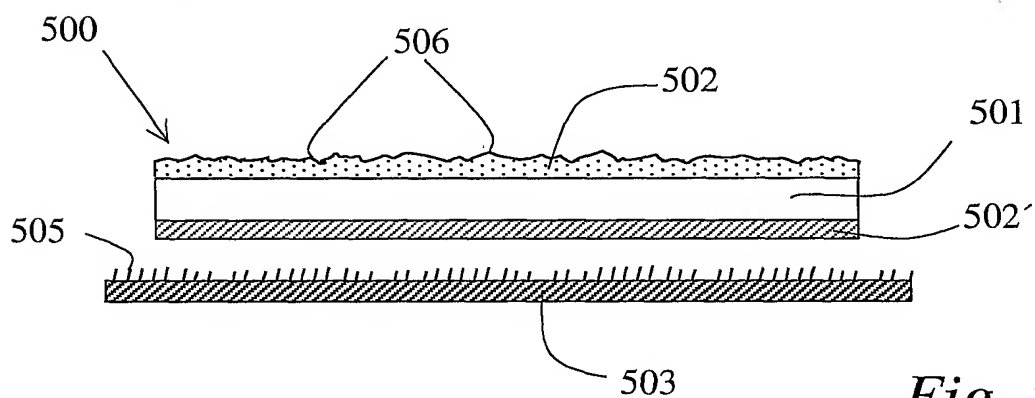
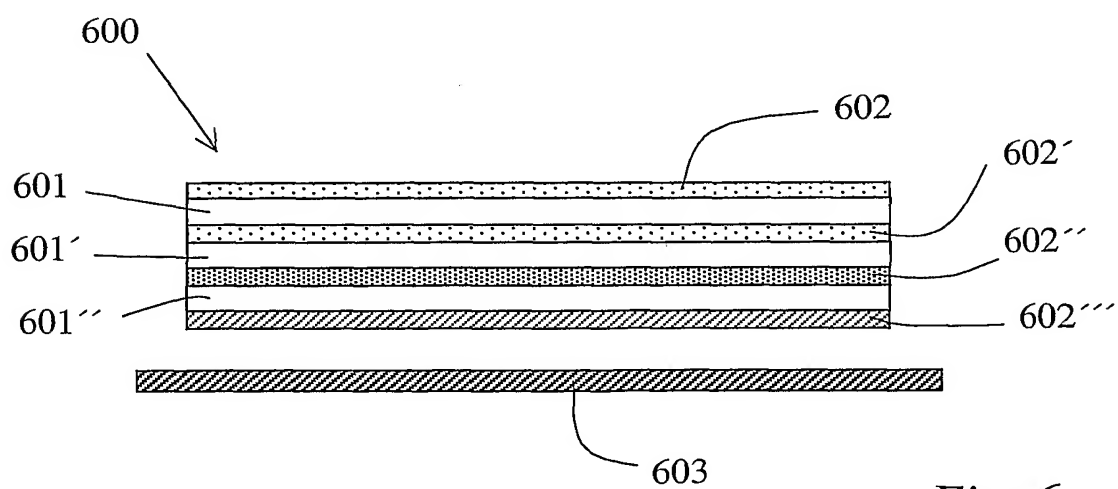
22. An electrically controlled display device according to any one of claims 1-20,
c h a r a c t e r i z e d i n that a back substrate (503) which is substantially blue is
arranged behind said at least one colored layer (502) with said active material (501)
5 therebetween, wherein said colored layer comprises a yellow filter.

23. An electrically controlled display device according to any one of claims 1-20,
c h a r a c t e r i z e d i n that a back substrate (503) which is substantially green is
arranged behind said at least one colored layer (502) with said active material (501)
10 therebetween, wherein said colored layer comprises a red filter.

1/2



2/2

*Fig. 4**Fig. 5**Fig. 6*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/01457

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G09F 9/35, G02F 1/1335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G09F, G02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4729637 A (Y.SATO ET AL), 8 March 1988 (08.03.88), column 2, line 24 - line 30; column 22, line 30 - line 38	1,6,8,13,18, 20
A	--	2-5,7,9-12, 14-17,19, 21-23
X	EP 0368260 A1 (KABUSHIKI KAISHA TOSHIBA), 16 May 1990 (16.05.90), column 6, line 25 - column 7, line 2, figures 1-2	1,6,8,13,15, 18,20
A	abstract	2-5,7,9-12, 14,16-17,19, 21-23
	--	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

3 April 2002

Date of mailing of the international search report

05 -04- 2002

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Mats Raidla /itw
Telephone No. +46 8 782 25 00

PCT/SE 01/01457

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
-----------	--	-----------------------

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/02

International application No.

PCT/SE 01/01457

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	4729637	A	08/03/88	JP	62131228 A	13/06/87
EP	0368260	A1	16/05/90	DE	68920702 D,T	14/06/95
				JP	2275903 A	09/11/90
				KR	9210016 B	10/11/92
				US	5042920 A	27/08/91
				US	5190794 A	02/03/93
				JP	2129601 A	17/05/90
US	5620781	A	15/04/97	JP	2850675 B	27/01/99
				JP	6018866 A	28/01/94
GB	2348039	A	20/09/00	CN	1267838 A	27/09/00
				DE	10011433 A	19/10/00
				GB	0005033 D	00/00/00
				JP	2000310949 A	07/11/00